§18. Simulation on Laser-Plasma Interaction and Fluid Dynamics in Inertial Confinement Fusion

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The development of short-pulse high-intensity lasers has opened new regimes in the study of laser produced plasmas. At intensities higher than 10^{18} W/cm^2, the electron quiver velocity for 1μm radiation becomes relativistic and the radiation pressure reaches more than 300 Mbar. In this regime, generation of fast particle [1-2] and MeV hard X-ray [3] have been predicted.

The fast ignitor concept proposed recently by Tabak et al. [4] could drastically change the ignition requirement for inertial confinement fusion program. The fast ignitor scheme is short intense laser is injected at the time around the maximum compression and additional heating on the compressed core by the energetic particles.

Recently, It was reported that the fast ions created by picosecond laser produced plasmas to fast ignitor studies [5]. Then, fusion yields and neutron emissions are measured from deuterated polystyrene targets irradiated with focused intensity of above 10^{18} W/cm^2. The fusion yield is 4.4×10^9.

This report is the result from the 1 and 2/2 D electromagnetic and relativistic particle in cell simulation, the interactions between intense subpico-second laser and multi species plasmas (electron, carbon, deuteron) are investigated. Figure 1 shows the normalized energy distribution function of the deuteron at 0.16 ps. The laser wave length and peak intensity are 1.05 μm and 10^{19} W/cm^2, respectively. The plasma density and temperature are solid density of polystyrene and 3 keV, respectively. The solid density is 300 times of the cutoff density (10^{21} cm^{-3}). The energy of accelerated deuteron reaches above 100 keV. The deuterons of the high energy reduce the energy and react with bulk deuteron. Figure 2 shows the areal fusion reaction density of deuteron - deuteron. The fusion rate is defined by the areal fusion reaction density times the focus area (10^{-5} cm^2).

In conclusion, the energetic electrons and ions are generated by intense laser pulse. The fusion yield is explained by the reaction between fast deuteron accelerated by the intense laser and low energy bulk deuteron.

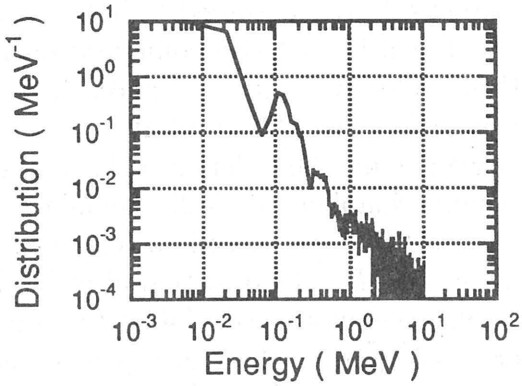

Fig. 1. Energy distribution function of deuteron at 0.16 ps.

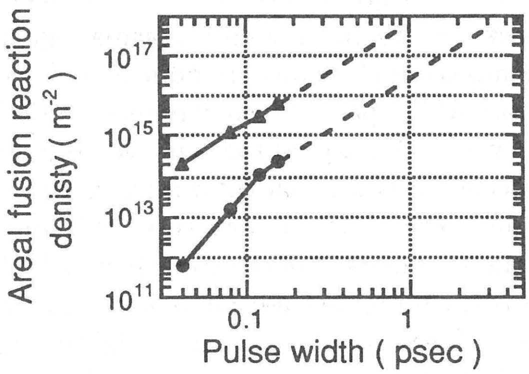

Fig. 2. Areal fusion reaction density of deuteron - deuteron. The circle and triangle show I_L = 10^{19} and 10^{20} W/cm^2, respectively.

References

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